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MOULT IN THREE SPECIES OF BULBULS OF THE GENUS *PYCNONOTUS* AT TIRUPATI HILLS OF THE EASTERN GHATS, INDIA[1]

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(*With four text-figures*)

Key words: moult score, primary moult, post nuptial moult, post-juvenile moult, suspended moult, moult duration, brood patch, recapture

Moult in three species of bulbuls, namely Whitebrowed *Pycnonotus luteolus,* Redwhiskered *Pycnonotus jocosus* and Redvented *Pycnonotus cafer* have been studied at the Tirupati Hills of the Eastern Ghats in India. The primary moult (commencement, duration and its relation with other moults) is described. Interspecific variation in commencement and duration is discussed. It is established that in Redwhiskered and Redvented the post-juvenile moult is rapid and shorter than the post-nuptial moult of adults. This study clearly indicates that all the adults of the three species undergo a complete post-nuptial moult soon after breeding is over. The post-juvenile moult starts one month after fledging.

Introduction

The Eastern Ghats are an important entity in the zoogeography of peninsular India and the distribution of the fauna and flora of the region has not been documented in detail. Whistler and Kinnear (1932-37) in a pioneering report based on the Vernay Scientific Survey conducted in 16 locations of the Eastern Ghats, touched upon some aspects of occurrence and distribution of the avifauna. Birds of the Eastern Ghats have been listed and described by Abdulali (1945, 1953), Raju and Selvin (1971), Raju and Price (1973), Hussain *et al.* (1976), Price (1979), and Beehler *et al.* (1987). Price (1979) described the seasonality of birds in the Eastern Ghats of Andhra Pradesh, and discussed briefly the moult pattern of the resident species.

The moult of Indian birds is poorly understood and little is known about the moult of any Indian bulbul. Some aspects of the moult cycles in a few Indian birds have been described (Naik and Naik 1965, Naik and Andrews 1966, Naik 1970). This paper provides details of the moult of three species of Bulbuls, namely Whitebrowed *Pycnonotus luteolus,* Redvented *Pycnonotus cafer* and Redwhiskered *Pycnonotus jocosus* Bulbuls in the Tirupati Hills of Eastern Ghats.

Study area and Methods

The Tirupati hills (13° 40' N, 79° 20' E) form a part of the Eastern Ghats range situated in the Chittoor district of southern Andhra Pradesh. Tirumala hills, which is a part of the Tirupati hills, lie about 1,000 m above sea level and the study was carried out in the dry deciduous forests located between the Kalyan dam and Bhakrapet village. These areas have been declared as the Sri Venkateswara Wildlife Sanctuary by the Andhra Pradesh State Forest Department. A portion of the Tirumala Hills comes within the Tirupati-Tirumala Devasthanam Forest. Most of the bulbuls were caught in the mixed forests of Tirumala hills which

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comprise clear-felled areas with secondary thickets of bamboo and plantations. The forests at Bhakrapet are natural scrub.

This paper is based on information collected from 1123 live birds examined for moult between June and November 1989. Birds were trapped in mist nets and were ringed, measured, weighed and examined for moult. In this paper the term 'juvenile' refers to a bird hatched out in the same breeding season (generally one month to four months old), and is separated from the adult by their morphological characters.

The primaries and secondaries as well as the rectrices (12 in number) were examined for moult. Primary feathers were numbered from distal (1) to proximal (10) including the much reduced distal first primary making a total of ten primaries, and eight secondaries were also similarly numbered. The moult was recorded on a separate moult card for each capture. Each primary and secondary feather was given a score of from "0" (old feathers) to "5" (full grown new feathers). The British Trust for Ornithology notation was adopted (Snow 1967) score "1" being a feather missing or in pin and "2", "3", "4" feathers one third, two thirds and nearly full grown respectively. The scores for all the 18 primaries and secondaries of one wing were then summed to give a maximum score 90 (50 for primaries and 40 for secondaries). A maximum score of 60 for the 12 rectrices was obtained in the same way. The body moult was recorded as "0" for no moult "S" slight moult, "A" and "C" for active and completed moult. The stages of the brood-patch was also recorded to relate the general moult to the breeding period.

Moult scores of different individuals were plotted against the dates of capture to estimate the duration, starting and finishing dates of moult. The slope determines the rate of moulting and the width, the spread in starting dates between individuals, as the moult score increases linearly with the time. Moult duration was also calculated from the rate of feather growth of individuals caught more than once during the moult. The relationship between primary and secondary scores is established by linear regression analysis (Fig. 2.).

Results

Feather replacement: Feather replacement follows the passerine sequence of descendant moult. The primary moult starts from the innermost primary and progresses outwardly. Moult is normally symmetrical in both wings. Though secondary and tail moult start after the commencement of primary moult they span the remaining period of the primary moult. Secondary moult initially starts from the first feather and later from the middle feathers and progresses in both the ways. Tail moult starts from the central feathers and the progress is outwards in Redvented and Redwhiskered. While in Whitebrowed it is not so regular and asymmetric moult is not uncommon.

Commencement of moult: Moult starts earliest in Whitebrowed as 30% of the birds examined in June had already commenced their primary moult. In Redvented, one out of 23 adults, commenced its moult in the last week of June and a single juvenile caught was also observed in moult at that time. Though post nuptial moult was noticed in very few individuals of Redwhiskered from the third week of July, the majority of the adult birds commenced their moult in third week of August or later and the stray juveniles caught (3 in June and 1 in July) had commenced their post juvenile moult in the last week of June. By August 45% of juveniles were in primary moult (Figs. 1 & 2).

Number of feathers growing concurrently: The number of primary, secondary and tail feathers growing concurrently for the bulbuls is given in Table 1. Up to five primaries concurrently growing are recorded only twice in Redwhiskered. Thirty percent of the Redwhiskered, 21% of Whitebrowed and 15% of Redvented were observed with three primaries growing concurrently. The commonest situation in all the three species was for these to be two feathers growing simultaneously; the next commonest being three feathers in Whitebrowed and Redwhiskered and only one in Redvented. The

TABLE 1

NUMBER OF FEATHERS GROWING IN RELATION TO MOULT SCORE

Primary Score	No. of Primaries growing concurrently						Secondary score	No. of Secondaries growing concurrently							Tail score	No. of Tail feathers growing concurrently											
	0	1	2	3	4	5		0	1	2	3	4	5	6		0	1	2	3	4	5	6	7	8	9	10	11	12
	WB 0	14	16	11	0	0		17	14	10	8	2	1	0		11	12	16	6	0	0	0	0	0	0	0	0	0
1-10	RW 2	7	15	14	2	0	1-10	15	43	39	20	7	0	0	1-0	4	10	56	13	4	0	0	0	0	0	0	0	0
	RV 6	5	9	2	0	0		8	18	8	6	2	0	0		3	3	22	4	5	0	0	0	1	0	0	0	0
	0	17	20	8	1	0		13	21	25	4	1	0	0		0	4	6	5	3	1	0	0	0	0	0	0	0
11-20	2	15	68	20	4	2	11-20	4	23	51	26	8	3	0	11-20	6	2	1	0	17	4	6	1	4	0	1	0	0
	3	17	17	4	2	0		1	12	11	12	1	0	0		2	0	3	2	8	1	2	1	1	0	0	0	0
	3	13	21	7	0	0		5	8	13	2	1	0	0		1	1	2	1	3	2	9	1	4	3	0	0	0
21-30	0	19	76	30	0	0	21-30	5	11	44	19	4	12	1	21-30	0	1	1	0	3	0	2	1	8	7	3	2	4
	1	8	29	3	0	0		1	15	15	3	0	2	0		0	1	0	1	2	2	1	2	3	1	3	0	0
	0	8	6	4	0	0		0	5	6	1	0	0	0		1	0	2	2	0	2	5	0	4	0	1	0	1
31-40	0	3	27	54	4	0	31-40	0	17	26	14	1	1	0	31-40	0	1	0	1	0	1	2	0	7	13	13	3	3
	1	4	14	4	0	0		0	16	14	2	0	0	0		1	0	0	0	0	2	1	1	3	0	1	0	0
	0	3	9	5	2	0										0	0	4	1	1	0	1	5	1	1	1	0	0
41-50	0	9	21	34	11	0									41-50	0	0	1	0	0	1	3	1	13	3	10	0	1
	0	12	13	12	3	0										2	0	0	0	0	2	1	1	3	0	1	0	0
																0	6	7	2	6	0	2	0	0	0	0	0	0
															51-60	0	3	10	2	9	4	9	1	18	3	0	0	0
																1	1	2	1	5	1	2	0	5	0	0	0	0

NOTE: WB — Whitebrowed, RW — Redwhiskered, RV — Redvented.

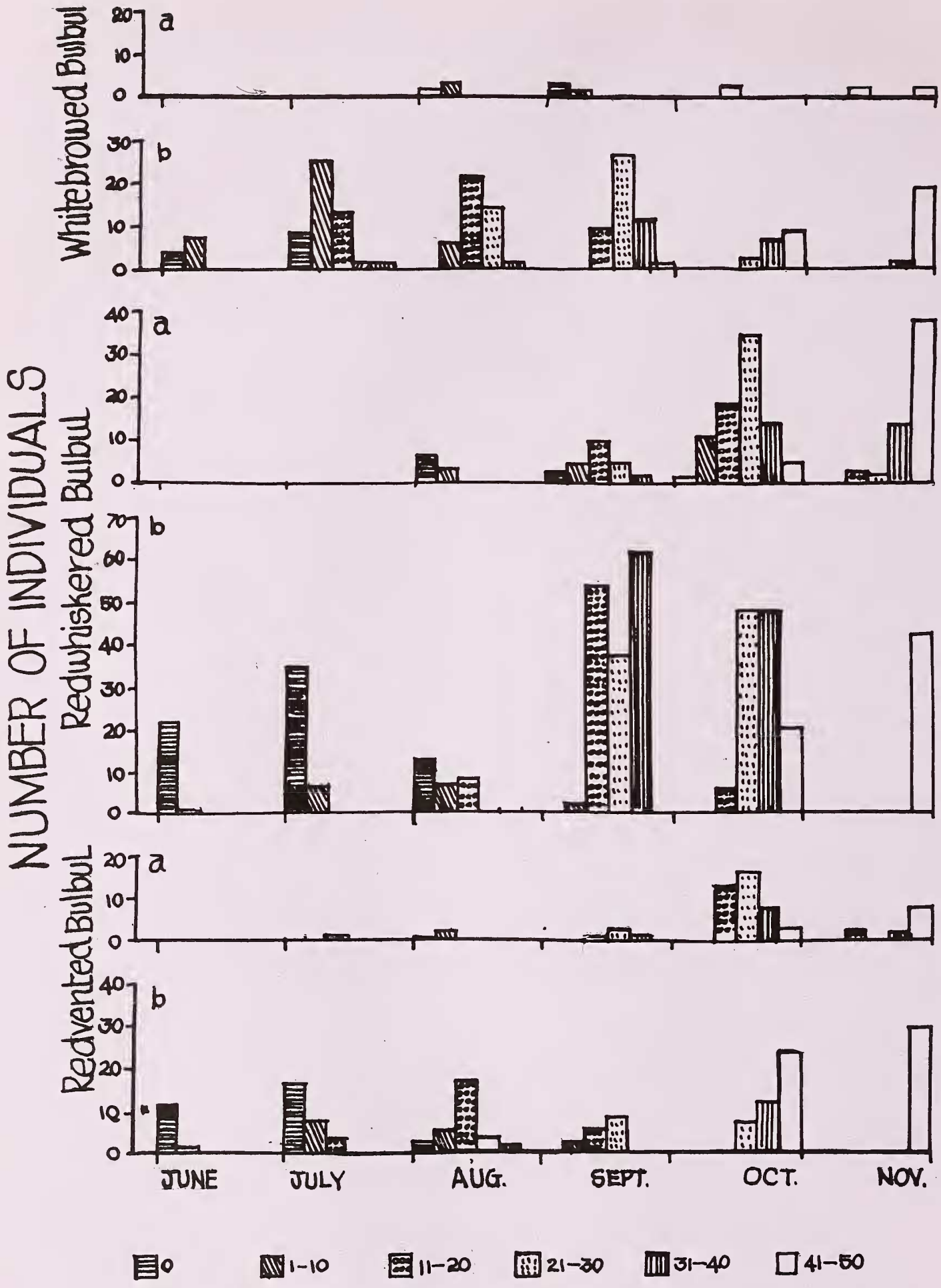

Fig. 1. Progress of primary moult in bulbuls. a) Juveniles; b) Adults.

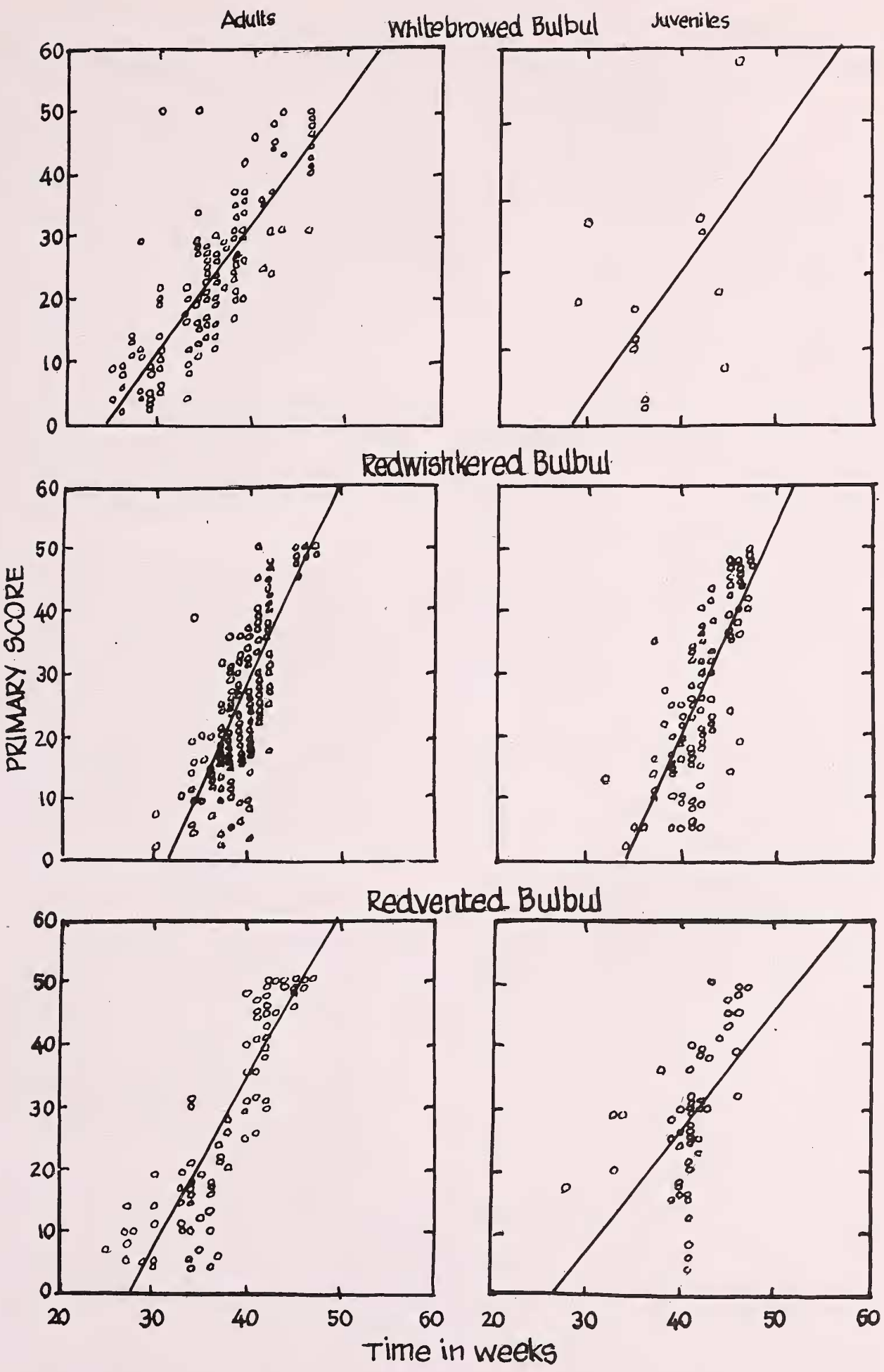

Fig. 2. Timing of primary moult in bulbuls. (Weeks are numbered from 1st week of January).

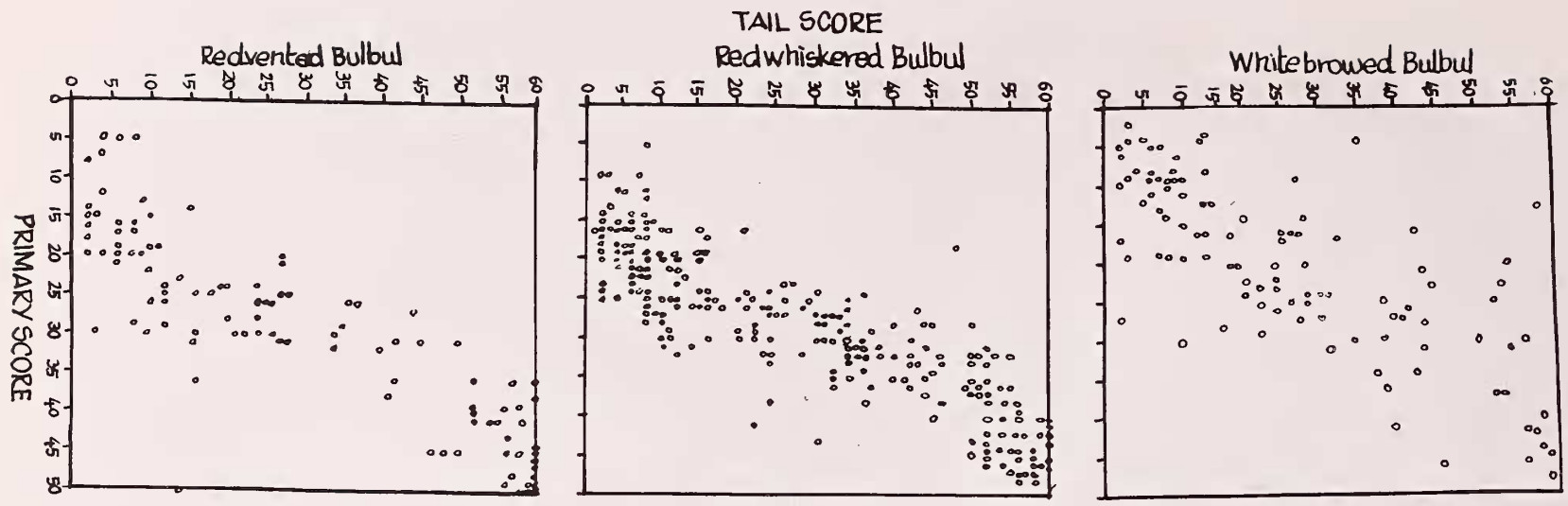

Fig. 3. Relation between primary and tail score in bulbuls.

highest number of concurrently growing primaries was observed in birds with primary moult scores of 41-45.

In Redwhiskered, individuals most commonly had three moulting secondaries, while in Redvented and Whitebrowed most individuals were recorded with two and one moulting secondary respectively. One individual of Redwhiskered had six secondaries growing concurrently.

Number of tail feathers growing concurrently varied from 2-12. In all the three species, two feathers growing concurrently was the commonest pattern.

Arrested or suspended moult: In arrested moult one or more feathers attain complete growth before the next feathers are dropped. Arrested moult was noticed in 6.5% of Redvented, 1.8% of Whitebrowed and 0.9% of Redwhiskered.

Moult duration: As individuals of Redvented and Redwhiskered were caught before commencement and just after completion of moult, the duration of moult could be recorded. Effective commencement of moult for Redwhiskered is mid-August and finishing time is third week of November. In the case of Redvented the starting and finishing time is mid July and the end of October (Fig. 2). Thus the approximate duration for Redwhiskered is 13 weeks and for Redvented 14 weeks. But most of the individuals of Whitebrowed commenced the moult in mid-June and completed in early November indicating a moult of approximately 18 weeks. In Redwhiskered four adults were caught twice during the moult and the rate of feather, replcement between the two captures was observed.

Post-juvenile moult is rapid for Redwhiskered and in general this species moults from the third week of September to the third week of November (9 weeks). The duration calculated for the two retrapped birds is 50 and 67 days respectively. While in Redvented the duration of post juvenile moult is almost the same as in Redwhiskered but commences one month earlier. For Whitebrowed the post-juvenile moult duration was not calculated as the sample size was too small.

Relation between primary and other moults: In none of the three species any secondaries moulted before commencement of primary moult. Secondary moult generally started when the primary score was 10-15 (Figs. 2 & 4). A few exceptions were noticed. Tail moult also commenced after the primary moult had started (Fig. 3). The secondary and tail moult are mostly completed at the same time as primary moult.

Slight body moult was noticed at the beginning of primary moult, but was most active when the primary moult score was between 30-40, and was usually completed at the same time as primary moult.

Breeding and moult: The first fledgling of Whitebrowed was sighted on 2nd June. Redvented was seen incubating eggs on 21st May and nestlings

were seen up to 22nd August. Whitebrowed is the earliest breeder among the three species, breeding was completed by July and all the adults caught in August were in moult. Redwhiskered and Redvented completed their breeding by August and all adults caught in September were with moulting primaries.

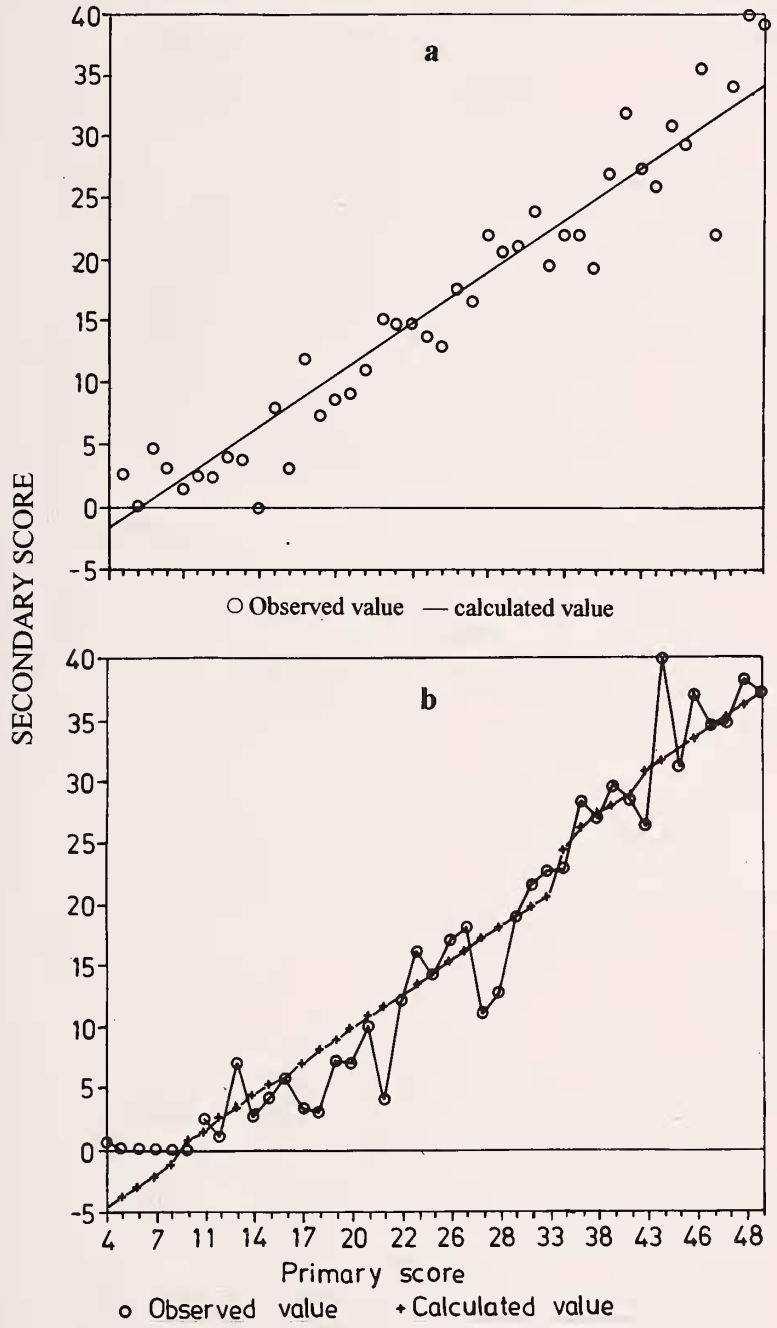

Fig. 4. Relation between primary and secondary score in bulbuls. (a) Whitebrowed; (b) Redvented.

Juveniles of all three species started their moult about one month after fledging, which is evident from the recapture of a juvenile Redvented on 10th October. During its first capture on 4th September the moult score was "0". After 36 days the score was just "6" with three innermost feathers in growth. To reach score "6" it might have taken less than eight days as the post-juvenile moult duration is just 8-9 weeks. The unmoulted adults noticed in August were still attending the nest.

Discussion

There is a distinct moulting period for each of the three bulbuls, this lasts from June to November. Adults of the three species undergo a complete moult soon after breeding is over. Similarly all the juveniles go through a complete moult, starting about one month after fledging. The pattern of post-juvenile moult is generally similar to post nuptial moult except in timing and duration. Late starting in post-juvenile moult compensated by the short duration, so that the end of moult is synchronized with the end of the post-nuptial moult of adults. Estimated duration indicates that Whitebrowed has a longer duration (18 weeks) than the other two species (Redvented and Redwhiskered 14 and 13 weeks respectively).

The moult duration is related to the rate of growth of individual feathers and the number of feathers growing concurrently. The maximum number of feathers concurrently growing occurred in Redwhiskered which had the shortest moult duration. However, Pienkowski and Knight (1976) stated that in waders of the Moroccan Coast, any interspecific variation in moulting rate was largely due to differences in the growth rates of the primaries, and not to differences in the number of primaries concurrently in growth.

Fogden (1972) reported that both in passerines and non-passerines, juveniles undergo a complete moult soon after fledging, which is generally similar to the post-nuptial moult of adults in its timing and duration. However, Snow (1967), found that the species moulting in temperate countries such as Britain, the juveniles of most species do not moult their remiges and rectrices after fledging. Our findings concur with Fogden's (1972) findings in Sarawak, except juveniles moult the tail; post-juvenile moult starts later than the post-nuptial moult and has a shorter duration.

Fogden (1972) also suggested that generally late moulting birds moult at a faster rate than those that begin early, and so finish at the same time. This is true in the three species of bulbuls studied. The late moulting Redwhiskered has shorter duration than the other two species which commence earlier. Similarly Redwhiskered and Redvented have shorter duration of post-juvenile moult than post-breeding moult as they commence their moult one month later than the adult. Fogden (1972) also estimated the duration of all the *Pycnonotus* sp. at Sarawak as 17 weeks which differs from our study. Price (1979) in his study of the breeding species of Lammasinghi of the Eastern Ghat range, mentioned that by July most of the birds have completed breeding and the adults undergo a complete post-nuptial moult which is completed by October. The complete post-juvenile moult was observed only in Redwhiskered and Redvented bulbuls, and also in the Redfronted Babbler *Stachyris rufifrons*. He observed that all the Redwhiskered caught from July 20 to 1st August were in primary moult which is contrary to our study. Of the 31 individuals only three were seen with primary moult during the corresponding period in the Tirupati Hills.

Moult and breeding do not overlap as the moult starts after breeding. When moult starts the broodpatch is either with scales or with calami to cover up the broodpatch, indicating the end of the brooding period. However, the possibility of moulting during the nestling period cannot be ruled out completely. The moult of wing and tail in the adults of five species of bulbul from Mopeia (Mozambique) and Nchalo (Malawi) occurred between December and July and immature birds start moulting when they are about three months old (Hanmer 1977). This timing is earlier than the timing of moult in bulbuls of Tirupati Hills where the young start moulting one month after fledging.

Food abundance may be one of the major factors determining the timing of the moult, and at Tirupati the fruiting season of *Zizyphus oenoplia* and *Scutia* sp., which are the favourite food of the bulbuls, coincides with the moult. Other trees in fruit were *Santalum* sp. and *Syzygium cumini* which were preferred by Redvented and Redwhiskered. During the fruiting season of the above trees (September and October), there was a heavy influx of Redwhiskered and Redvented mostly to the Tirumala hills which resulted in a higher catches of these two species at this time. Vertical and horizontal movements in bulbuls at Lammasinghi was reported by Price (1979) who ascribed the low rate of recapture to such movements. The percentage of recapture of the bulbuls at Tirupati hills was also very low probably indicating dispersal immediately after breeding. In comparison, more fledglings of Redvented were sighted than of the other two species, which may be due to the higher breeding success of Redvented than Redwhiskered and Whitebrowed or to less movement out of the area.

Miller (in Fogden 1972) suggested that in tropical America the resident birds breed and moult during the part of the year when the northern migrants are absent, which implies competition between the resident and migrant species. At Tirupathi hills the residents complete their breeding before the arrival of the migrants but extend the moult till November when the migrants are present.

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